[Name of Document] DESCRIPTION

[Title of the Invention]

CONTROL SYSTEM, CONTROL METHOD, PROCESS SYSTEM, AND

COMPUTER READABLE STORAGE MEDIUM AND COMPUTER PROGRAM

5   [Field of the Invention]

[0001]

The present invention relates to a control system, a

control method, and a process system, which include a

process apparatus that performs a predetermined process on

10   an object to be processed at the time of fabricating, for

example, a semiconductor device, a computer readable storage

medium, and a computer program.

[Description of the Related Art]

[0002]

15   In a fabrication process for semiconductor devices, for

example, various processes are performed on a semiconductor

wafer (hereinafter simply written as wafer), for which

various kinds of process apparatuses are used. There is,

for example, a cleaning apparatus which performs soaking and

20   processing a wafer in a single process bath or plural

process baths retaining a process liquid thereafter drying,

as such a process apparatus.

[0003]

Such a cleaning apparatus is provided with a control

25   system that receives various kinds of detection data from a

temperature sensor which detects the temperature of a

process liquid to be supplied to a substrate, a

concentration sensor which detects the concentration of the process liquid, a position sensor which detects the position of the process liquid in the bath, and the like to detect the status of the cleaning apparatus, and controls the cleaning apparatus based on various kinds of detection data. When the detected value of a sensor exceeds a preset allowance value while the apparatus is in operation, the control system generates an alarm, considering that there is a possible occurrence of a failure in the apparatus.

[0004]

In a wafer process, a plurality of process apparatuses are laid out to construct a process system, but the size of such a process system recently is becoming larger, so that there are ever increasing demands for integrated control of multiple process apparatuses.

[0005]

Accordingly, individual process apparatuses are provided with control units that are connected to a host computer, which performs tracking of individual process apparatuses, stores process data, received from the process apparatuses, as a history, displays the contents thereof on a display device, and performs correction of various parameters, abnormality detection, and so forth of the process apparatuses, through exchange of various kinds of data with the control units of the process apparatuses.

[0006]

Patent Literature 1 discloses that because process data

to be stored is restrictive and it is difficult to find an

abnormality in, and degrading of the characteristic of, a

process apparatus early in an integrated control system

using such a host computer, a controller, which collects all

5   process data generated by the control units of individual

process apparatuses, analyzes the collected process data and

outputs the analysis results, is provided in addition to the

host computer. This can increase process data to be grasped

and can ensure early detection of a change in the status of

10   each process apparatus with time.

[0007]

However, process data from individual process

apparatuses in such a system is vast. So is alarm

information from the individual process apparatuses. It is

15   not therefore easy to determine the status of the process

apparatus from such information, and there have been demands

of sufficiently managing an abnormality in apparatus and the

service life of the apparatus. The use conditions of the

apparatus differ from one user to another, so that even if

20   an abnormality in apparatus, the abnormality and the service

life of the apparatus are determined equally from process

data, there may be a case where an abnormality in apparatus

and reaching the service life of the apparatus have not

actually occurred yet.

25   [Patent Literature 1]

Unexamined Japanese Patent Application

KOKAI Publication No. H11-16797

[Disclosure of Invention]

[0008]

It is an object of the present invention to provide a control system and a control method, which can determine the status of a process apparatus based on alarm information and sufficiently manage an abnormality in apparatus, the service life of the apparatus, etc., a process system equipped with such a control system, and a computer readable storage medium and a computer program, which perform such control.

[0009]

It is another object of the invention to provide a control system and a process method, which can predict or surely detect the actual abnormality in apparatus, and service life of the apparatus on the user level, and a computer readable storage medium and a computer program, which perform such control.

[0010]

According to the first aspect of the invention, there is provided a control system comprising control means that controls a process apparatus, which performs a predetermined process on an object to be processed, based on information to be detected in the process apparatus; and alarm generation means which generates an alarm when the detected information is off a predetermined range, wherein the control means grasps a generation state of the alarm which is generated from the alarm generation means, and gives warning when the generation state reaches a predetermined

threshold.

[0011]

According to the second aspect of the invention, there is provided a control system comprising control means that controls a plurality of process apparatuses, which perform predetermined processes on an object to be processed, based on information to be detected in the process apparatuses; and alarm generation means which generates an alarm when the information to be detected is off a predetermined range, the control means including a plurality of apparatus control units that respectively control the plurality of process apparatuses based on plural pieces of information to be detected in the individual process apparatuses, a host computer that receives partial information from the individual process apparatuses and controls the individual process apparatuses based on that information, and a control apparatus that receives all or nearly all information from the individual process apparatuses and controls the individual process apparatuses based on that information, the control apparatus including means that collects information received from the individual control units and alarm information received from the alarm generation means, means that analyzes the collected information, and means that grasps a generation state of the alarm generated based on the alarm information, and gives warning when the generation state reaches a predetermined threshold.

[0012]

According to the third aspect of the invention, there is provided a control method that controls a process apparatus, which performs a predetermined process on an object to be processed, based on plural pieces of information to be detected in the process apparatus, the method comprising: grasping a generation state of an alarm, which is generated when the detected information is off a predetermined range, and giving warning when the generation state reaches a predetermined threshold.

[0013]

According to the fourth aspect of the invention, there is provided a process system comprising a process apparatus which performs a predetermined process on an object to be processed, and a control system which controls the process apparatus, the control system including control means that controls a process apparatus, which performs a predetermined process on an object to be processed, based on information to be detected in the process apparatus; and alarm generation means which generates an alarm when the detected information is off a predetermined range, wherein the control means grasps a generation state of the alarm which is generated from the alarm generation means, and gives warning when the generation state reaches a predetermined threshold.

[0014]

According to the fifth aspect of the invention, there is provided a process system comprising which performs a

predetermined process on an object to be processed, and a

control system which controls the process apparatus, the

control system including control means that controls a

plurality of process apparatuses, which perform

5   predetermined processes on an object to be processed, based

on information to be detected in the process apparatuses;

and alarm generation means which generates an alarm when the

information to be detected is off a predetermined range, the

control means including

10   a plurality of apparatus control units that respectively

control the plurality of process apparatuses based on plural

pieces of information to be detected in the individual

process apparatuses, a host computer that receives partial

information from the individual process apparatuses and

15   controls the individual process apparatuses based on that

information, and a control apparatus that receives all or

nearly all information from the individual process

apparatuses and controls the individual process apparatuses

based on that information, the control apparatus including

20   means that collects information received from the individual

control units and alarm information received from the alarm

generation means, means that analyzes the collected

information, and means that grasps a generation state of the

alarm generated based on the alarm information, and gives

25   warning when the generation state reaches a predetermined

threshold.

[0015]

According to the sixth aspect of the invention, there is provided a computer readable storage medium containing software that allows a computer to control a process apparatus, which performs a predetermined process on an

5   object to be processed, based on plural pieces of information to be detected in the process apparatus, wherein the software grasps a generation state of an alarm, which is generated when the detected information is off a predetermined range, and gives warning when the generation

10   state reaches a predetermined threshold.

[0016]

According to the seventh aspect of the invention, there is provided a computer program containing software that allows a computer to control a process apparatus, which

15   performs a predetermined process on an object to be processed, based on plural pieces of information to be detected in the process apparatus, wherein the software grasps a generation state of an alarm, which is generated when the detected information is off a predetermined range,

20   and gives warning when the generation state reaches a predetermined threshold.

[0017]

According to the invention, as the generation state of an alarm which is generated from the alarm generation means

25   is grasped, and warning is given when the generation state reaches a predetermined threshold, an abnormality in apparatus and the service life of the apparatus can be

detected or predicted early. Because it is possible to set the threshold of the generation state of an alarm which is generated from the alarm generation means, and analyze the generation state of the alarm according to the abnormality

5 setting set arbitrarily to detect an abnormality in apparatus, warning can be given when an apparatus status, such as a process abnormality which a user actually wants to grasp, is reached. This makes it possible to surely detect or predict an abnormality in apparatus and the service life

10 of the apparatus earlier. Specifically, as a user sets the threshold at which warning of the generation state of an apparatus alarm, such as the number of alarm generations within a predetermined time and a time from an alarm generation to the next alarm generation, and it is

15 determined that an abnormality in apparatus has occurred when the threshold is reached, the status of the process apparatus can be determined surely on the user level, an abnormality in apparatus and the service life of the apparatus can be detected or predicted earlier and surely.

20 [Brief Description of Drawings]

[0018]

[FIG. 1] Block diagram showing the general structure of a process system according to one embodiment of the invention.

25 [FIG. 2] Diagram showing the structure of a portion associated with process data transfer in a main controller (MC) in a process apparatus to be used in the process system

according to one embodiment of the invention.

[FIG. 3]　Perspective view showing one example of the process apparatus to be used in the process system according to one embodiment of the invention.

5　　[FIG. 4]　Plan view showing one example of the process apparatus to be used in the process system according to one embodiment of the invention.

[FIG. 5]　Schematic diagram showing a first chemical bath and its piping system in the process apparatus to be

10　used in the process system according to one embodiment of the invention.

[FIG. 6]　Block diagram showing main detection means connected to a block controller (BC).

[FIG. 7]　Diagram showing one example of an alarm

15　generation state to be detected by an FDC function section of an AGC.

[FIG. 8]　Diagram showing another example of the alarm generation state to be detected by the FDC function section of the AGC.

20　　[FIG. 9]　Diagram showing one example of a graph display of circumstances of alarm generation when a detection condition is designated in the FDC function section of the AGC.

[FIG. 10]　Diagram showing another example of the graph

25　display of alarm generation circumstances when a detection condition is designated in the FDC function section of the AGC.

[Best Mode for Carrying Out the Invention]

[0019]

An embodiment of the invention will be described below referring to the accompanying drawings.

The following discusses a process system equipped with a process apparatus which cleans a wafer as a substrate by performing a liquid process thereon. FIG. 1 is a block diagram showing the general structure of the process system according to the embodiment.

[0020]

This process system 1 has a plurality of process apparatuses 10 which clean a wafer by performing a liquid process thereon, and the individual process apparatuses 10 are controlled by a block controller (BC) 11 as a low-rank control system and a main controller (MC) 12 as a high-rank control system. The process system 1 has a host computer 15 which performs the general control of the system, and an advanced group controller (hereinafter written as AGC) which analyzes process data generated by the control systems of the individual process apparatuses and outputs the results.

[0021]

As shown in FIG. 2, the main controller (MC) 12 has a control unit 12a, which receives a detection signal through the block controller (BC) 11 and sends a control signal to the individual components of the process apparatus 10 based on the detection signal, an abnormality detecting section 20, which analyzes process information received from the control

unit 12a and detects an abnormality, an alarm generation

section 21 which generates an alarm based on abnormality

detection information from the abnormality detecting section

20, a memory 18 where entire process information and alarm

5   information, which are received from the process apparatus

10 via the block controller (BC) 11 and subjected to signal

processing in the control unit 12a, are temporarily stored,

an HCI transmission buffer 19, which acquires some preset

types of process data (data 1, 3) from the memory 18 and

10   writes the information, an HCI (Host Communication

Interface) 13 as logical interface means to the host

computer 15, and an RAP (Remote Agent Process) 16 as logical

interface means to an AGC 17. Exchange of various kinds of

data with the host computer 15 through a data transmission

15   system 14, such as TCP/IP, is executed by the HCI 13.

Exchange of various kinds of data with the AGC 17 is

executed by the RAP 16 through the data transmission system

14.

[0022]

20   The HCI 13 selects some preset types of process data

from all the process data acquired from the process

apparatus 10 by the main controller 12, and sends the data

to the host computer 15. That is, the HCI 13 acquires some

preset types of process data (data 1, 3) from the memory 18

25   where entire process data generated by the main controller

(MC) 12 are temporarily stored, writes the data in the HCI

transmission buffer 19, and sends the contents of the HCI

transmission buffer 19 to the host computer 15 at a time.
Status data or the like generated by the main controller
(MC) 12 is also sent.

[0023]

5   The RAP 16 sends all the process data acquired from the
process apparatus 10 by the main controller (MC) 12 to the
AGC 17 unconditionally. That is, the RAP 16 sequentially
reads process data, stored in the process data storage
memory 18 in the main controller (MC) 12, from the top, and
10   transfers it with the data structure unchanged to the AGC 17.
It is to be noted however that an operation to an extent,
such as changing the sequential order of data or removal of
just a part of data may be carried out here.

[0024]

15   The host computer 15 performs the general operational
control of the individual process apparatuses 10, such as
tracking of each process apparatus 10 through exchange of
various kinds of data with the main controller (MC) 12 of
each process apparatus 10.

20   [0025]

The AGC 17 executes processes including intensive
management of recipes (process condition values) for each
process apparatus and process control of each process
apparatus 10 based on the recipes, analysis and statistical
25   processing of all process data acquired from each process
apparatus 10, intensive monitoring of process data and its
analysis/statistical results, a process of reflecting the

analysis/statistical results on recipes, and the like.

[0026]

The AGC 17 comprises an AGC server 17a and an AGC client 17b.

5   [0027]

The AGC server 17a has a communication I/F (Interface section) 22, an EQM control unit 23 and a database 24. The communication I/F (Interface section) 22 transmits and receives various kinds of data between the main controller

10   (MC) 12 of each process apparatus 10 and the AGC client 17b via the data transmission system 14. The EQM control unit 23 mainly performs correction of various parameters of processes for each process apparatus based on predefined process conditions and process data acquired from each

15   process apparatus 10, and processes, such as storage of received parameters into the database 24 and retrieval of process data to be transferred to the AGC client 17b from the database 24.

[0028]

20   The AGC client 17b has a data analysis section 25, which performs analysis and statistical processing of process data transferred from the AGC server 17a, a data converting section 26 which converts acquired process data and its analysis results or the like to data of the format

25   that a client user can use and process, a data display section 27 which displays converted data on a monitor or the like, a recipe correcting section 28 which updates recipes

(process conditions) for optimization based on the results of analysis of process data including measured data of the film thickness and the like on an object to be processed, and an FDC (Fault Detection and Classification) function section 29 having functions of defining an abnormality in apparatus on the user level besides generation of an apparatus alarm, analyzing the generation state of the alarm according to the abnormality setting arbitrarily made, and detecting an abnormality in apparatus in real time. Recipes may be stored on a hard disk or a semiconductor memory, or may be set retained in a portable storage medium, such as a CD-ROM or DVD, at predetermined positions. Further, recipes may be transferred adequately from another apparatus, for example, via an exclusive circuit.

[0029]

Next, one example of the process apparatus 10 will be discussed. FIG. 3 is a perspective view of the process apparatus 10, and FIG. 4 is a plan view thereof.

[0030]

The process apparatus 10 mainly comprises a load/unload section 31 which performs loading and unloading and storage or so of a carrier C where a wafer W is retained horizontally, a processing section 32 which performs a cleaning process on the wafer W using a predetermined chemical solution and a drying process or the like, and an interface section 33 which conveys the wafer W between the load/unload section 31 and the processing section 32.

[0031]

The load/unload section 31 comprises a carrier load/unload section 34 where a stage 41 for mounting a carrier C capable of retaining a predetermined number of, for example, twenty-five, wafers W is formed, and a carrier stock section 35 capable of storing a plurality of carriers C. The carrier C retains wafers W horizontally at predetermined intervals, with its one side being a load/unload port for the wafers W, which has such a structure as to be openable and closable with a lid. The carrier stock section 35 is provided with a plurality of carrier holding members 43 which hold the carriers C. A carrier C which retains unprocessed wafers W and is mounted on the stage 41 is carried into the carrier stock section 35 by a carrier conveying device 42, while a carrier C which retains processed wafers W is carried to the stage 41 from the carrier stock section 35 using the carrier conveying device 42.

[0032]

A shutter 44 is provided between the carrier load/unload section 34 and the carrier stock section 35. The shutter 44 is opened at the time of transferring the carrier C between the carrier load/unload section 34 and the carrier stock section 35, and is closed otherwise to isolate the atmosphere between the carrier load/unload section 34 and the carrier stock section 35.

[0033]

The carrier conveying device 42 has an arm 42a, such as a multi-joint arm or a telescopic arm, which is driven in such a way as to be able to move at least a carrier C, for example, in the X direction, and the carrier C is conveyed

5   held with such an arm 42a. The carrier conveying device 42 can be driven in the Y direction and Z direction (height direction) by an unillustrated Y-axis drive mechanism and Z-axis drive mechanism, so that the carrier C can be mounted on the carrier holding member 43 laid out at a predetermined

10 position.

[0034]

In FIG. 4, the carrier holding members 43 are provided near the wall surface where the carrier stock section 35 is formed, in plural stages, for example, four stages, at each

15 location in the height direction. The carrier stock section 35 serves to temporarily store carriers C retaining unprocessed wafers W, or store empty carriers C from which the wafers W have been removed.

[0035]

20 A window 46 is formed at the boundary between the carrier stock section 35 and the interface section 33, and an inspection/load/unload stage 45 having a structure similar to that of the carrier holding member 43 is provided on the carrier stock section 35 side of the window 46 so

25 that the carrier C can be mounted in such a way that the lid of the carrier C faces the window 46. The carrier conveying device 42 may hold the carrier C for a given time at

predetermined space facing the window 46 without providing

the inspection/load/unload stage 45. A lid open/close

mechanism 47 for opening and closing the lid of the carrier

C mounted on the inspection/load/unload stage 45 is provided

5   on the carrier stock section 35 side of the window 46, so

that with the window 46 and the lid of the carrier C being

open, the wafers W in the carrier C can be carried out

toward the interface section 33, or wafers W can be carried

into an empty carrier C from the interface section 33 side.

10   The lid open/close mechanism 47 may be provided on the

interface section 33 side of the window 46.

[0036]

A wafer inspecting device 48 for measuring the quantity

of wafers W in the carrier C is provided on the interface

15   section 33 side of the window 46. The wafer inspecting

device 48 checks the quantity of the wafers W by causing,

for example, an infrared sensor head having a transmission

section and a reception section to scan in the Z direction

in the vicinity of the X-directional ends of the wafers W

20   retained in the carrier C and detecting a signal of

transmitted light or reflected light of the infrared light

between the transmission section and the reception section.

It is preferable to use the wafer inspecting device 48 that

has a function of detecting the retained state of wafers W,

25   such as whether or not the wafers W are laid out one on

another in parallel at predetermined pitches in the carrier

C or whether or not the wafers W are retained misaligned and

obliquely, in parallel to checking of the quantity of wafers W. The quantity of the wafers W may be detected using the sensor after the retained state of the wafers W is checked. The wafer inspecting device 48 is wire-connected as a signal

5   input device to the block controller (BC) 11, and sends the detected quantity retained and the retained state as output signals to the block controller (BC) 11.

[0037]

The operations of the carrier conveying device 42 and

10   the wafer inspecting device 48 are controlled by the host computer 15 via the block controller (BC) 11 and the main controller (MC) 12. For example, the carrier conveying device 42 is controlled in such a way that after the quantity of wafers W in a carrier C is checked by the wafer

15   inspecting device 48, the carrier C is stored in the carrier stock section 35. The opening/closing of the shutter 44, the opening/closing of the window 46 and the operation of the lid open/close mechanism 47 are controlled interlocked with the movement of the carrier conveying device 42.

20   [0038]

The interface section 33 is provided with a wafer load/unload device 49, a wafer transfer device 51 and a wafer conveying device 52. The wafer transfer device 51 comprises an attitude conversion mechanism 51a which

25   exchanges a wafer W with the wafer load/unload device 49 and converts the attitude of the wafer W, and a wafer vertical holding mechanism 51b which exchanges a wafer W between the

attitude conversion mechanism 51a and the wafer conveying device 52.

[0039]

The wafer load/unload device 49 unloads wafers W in the carrier C through the window 46 and transfers it to the attitude conversion mechanism 51a, and receives wafers W having undergone the liquid process from the attitude conversion mechanism 51a and carries into the carrier C. The wafer load/unload device 49 has two kinds of arms, arms 49a which carry unprocessed wafers W and arms 49b which carry a processed wafers W. A predetermined number of the arms 49a and 49b are laid out at predetermined intervals in the Z direction according to the layout pitch of wafers W in the carrier C, so that the arms 49a and 49b can hold plural wafers W retained in the carrier C at a time. In the state shown in FIG. 4, the arms 49a and 49b are movable (slidable) or expandable in the direction of an arrow A, and are elevatable by a predetermined distance in the Z direction. Further, the entire wafer load/unload device 49 is so constructed as to be rotatable in a θ direction, so that the arms 49a and 49b can access to any of the carrier C mounted on the inspection/load/unload stage 45, and the attitude conversion mechanism 51a.

[0040]

In the wafer load/unload device 49, for example, with the arms 49a being on the wafer transfer device 51 side, the arms 49a are inserted under the wafers W and is lifted

upward by a predetermined distance to hold the wafers W,

after which the arms 49a are moved in the opposite direction

to carry out the wafer W of the carrier C. Next, the whole

wafer load/unload device 49 is rotated by 90 degrees, and

5   then the arms 49a are moved to transfer the wafers W held on

the arms 49a to the attitude conversion mechanism 51a. With

the arms 49b being on the processing section 32 side, on the

other hand, the arms 49b are moved to take out wafers W

having undergone the liquid process from the attitude

10   conversion mechanism 51a, after which the whole wafer

load/unload device 49 is rotated by 90 degrees, and then the

arms 49b are set on the wafer transfer device 51 side and

are moved to carry the wafers W held on the arms 49b moved

to transfer the wafer W held on the arm 49b into an empty

15   carrier C.

[0041]

In the attitude conversion mechanism 51a of the wafer

transfer device 51, a plurality of horizontal wafers W are

received from the wafer load/unload device 49 through a

20   guide member, and the guide member is rotated in that state

to change the state of the wafers W to the vertical state.

[0042]

The wafer vertical holding mechanism 51b can retain two

carriers of, or 50, wafers W whose state has been changed to

25   the vertical state by the attitude conversion mechanism 51a

at a layout pitch which is half the layout pitch of wafers

in the carrier C, and transfers the two carriers of wafers W

to the wafer conveying device 52.

[0043]

The wafer conveying device 52 delivers vertical wafers W to or from the wafer vertical holding mechanism 51b and carries unprocessed wafers W into the processing section 32, or carries out wafers W having undergone the liquid process or so from the processing section 32 and transfers the wafers W to the wafer vertical holding mechanism 51b. In the wafer conveying device 52, wafers W are held by three chucks 58a to 58c. The wafer conveying device 52 moves in the X direction along a guide rail 53 to be able to move into/out from the processing section 32 in such a way that the wafer conveying device 52 can deliver wafers W to or from the wafer vertical holding mechanism 51b and carry wafers W into the processing section 32.

[0044]

To check whether or not wafers W having undergone the liquid process are damaged or misaligned or so, a wafer detection sensor 57 to check the layout state of wafers W is provided at a position where the wafers W are delivered between the wafer vertical holding mechanism 51b and the wafer conveying device 52. The wafer detection sensor 57 is not limited to such a position but can be any position where a check is done while processed wafers W are carried to the wafer load/unload device 49. The wafer detection sensor 57 is wire-connected as a signal input device to the block controller (BC) 11 and sends the detected value as an output

signal to the block controller (BC) 11.

[0045]

The interface section 33 is provided with a parking area 40a on the side of the position where wafers W are exchanged between the wafer vertical holding mechanism 51b and the wafer conveying device 52, so that unprocessed wafers W, for example, can stand by in the parking area 40a. For instance, at the time the liquid process or the dry process is performed on wafers W of one lot, wafers W for which the liquid process are to be initiated next should have been carried to the parking area 40a using the time during which the wafer conveying device 52 need not be operated. This can shorten the time for moving wafers W to the processing section 32 as compared with, for example, a case where wafers W are carried from the carrier stock section 35, so that the throughput can be improved.

[0046]

The processing section 32 comprises a liquid process unit 38, a drying unit 39, and a parking area 40b, which are arranged in the order of the drying unit 39, the liquid process unit 38 and the parking area 40b from the interface section 33 side. The wafer conveying device 52 can move inside the processing section 32 along the guide rail 53 extending in the X direction.

[0047]

The parking area 40b, like the parking area 40a, is where unprocessed wafers W are to sand by. Using the time

during which the wafer conveying device 52 need not be

operated for the liquid process or the dry process is

performed on wafers W of one lot, wafers W for which the

liquid process are to be initiated next are carried to the

5   parking area 40b. As the parking area 40b is adjacent to

the liquid process unit 38, the time for moving wafers W can

be shortened at the time of initiating the liquid process,

so that the throughput can be improved.

    [0048]

10   The liquid process unit 38 has a first chemical bath 61,

a second chemical bath 63, a third chemical bath 65, a first

rinse bath 62, a second rinse bath 64, and a third rinse

bath 66, which are arranged in the order of the first

chemical bath 61, the first rinse bath 62, the second

15 chemical bath 63, the second rinse bath 64, the third

chemical bath 65, and the third rinse bath 66 from the

parking area 40b side, as shown in FIG.4. A conveying

device 67 for transferring wafers W between the first

chemical bath 61 and the first rinse bath 62, a conveying

20 device 68 for transferring wafers W between the second

chemical bath 63 and the second rinse bath 64, and a

conveying device 69 for transferring wafers W between the

third chemical bath 65 and the third rinse bath 66 are

provided.

25   [0049]

    A chemical solution for removing an organic stain or a

surface metal impurity is retained in the first chemical

bath 61. As a chemical solution for removing an organic
stain or a surface metal impurity, an SPM solution (a mixed
solution of concentrated sulfuric acid and a hydrogen
peroxide solution) heated to, for example, around 130 ℃ is

5   retained. A chemical solution for removing a deposit, such
as particles, e.g., an SC-1 solution (a mixed solution of
ammonia, hydrogen peroxide and water) is retained in the
second chemical bath 63, and an etchant for etching an oxide
film formed on the top surface of a wafer W, e.g., a diluted

10   hydrofluoric acid (DHF), is retained in the third chemical
bath 65. As an etchant, in addition to the diluted
hydrofluoric acid, a mixture of a hydrofluoric acid (HF) and
ammonium fluoride (buffered hydrofluoric acid (BHF)) can be
used. In case of etching a nitride film formed on the top

15   surface of a wafer W, phosphate can be used as an etchant.
The first to third rinse baths 62, 64 and 66 are for
respectively removing chemical solutions adhered to a wafer
W through the liquid processes in the first to third
chemical baths 61, 63 and 65, and various kinds of rinsing

20   schemes, such as overflow rinse and quick dump rinse, are
used.

[0050]

the conveying device 67 has a drive mechanism
elevatable in the Z direction, and operates in such a way as

25   to lower wafers W received from the wafer conveying device
52 to be bathed in the first chemical bath 61, pull them up
after a predetermined time, then move the wafers W in

parallel in the X direction, bathe and hold the wafers W in the first rinse bath 62 for a predetermined time, then pull them up. The wafers W that have undergone the process in the first rinse bath 62 are returned to the chucks 58a to 58c of the wafer conveying device 52, and then are carried to the conveying device 68 from the wafer conveying device 52. The conveying devices 68 and 69 have structures similar to the structure of the conveying device 67, and operate similarly.

[0051]

A liquid-process-unit thermometer 59 which detects the temperature of the atmosphere in the liquid process unit 38, and a liquid-process-unit manometer 60 which detects pressure are provided in the liquid process unit 38. The liquid-process-unit thermometer 59 and the liquid-process-unit manometer 60 are wire-connected as signal input devices to the block controller (BC) 11, and respectively send the detected temperature and pressure to the block controller (BC) 11.

[0052]

The drying unit 39 is provided with a rinse bath 54 and a chuck cleaning mechanism 56 which cleans the chucks 58a to 58c of the wafer conveying device 52, and a dry chamber (not shown) to which vapor of, for example, isopropyl alcohol (IPA) is supplied to dry wafers W is provided at the upper portion of the rinse bath 54. A conveying device 55 which conveys between the rinse bath 54 and the dry chamber is

provided so that wafers W rinsed in the rinse bath 54 are

pulled up and subjected to IPA drying in the dry chamber.

The conveying device 55 is constructed in a similar way as

the above-described conveying device 67 or the like, except

5   that it cannot move in the X direction, so that exchange of

the wafers W with the wafer conveying device 52 is possible.

[0053]

The first chemical bath 61, as shown in FIG. 5,

comprises a box-shaped inner bath 80 with sizes large enough

10 to retain wafers W and outer bath 81. The top side of the

inner bath 80 is open, so that wafers W are carried in and

out of the inner bath 80 through the opening at the top side.

The outer bath 81 is attached surrounding the opening of the

inner bath 80 in such a way as to receive a chemical

15 solution overflowing from the top end of the inner bath 80.

Further, liquid level sensors 82a and 82b for measuring the

positions of the liquid levels are provided at the liquid

levels of the chemical solutions to be retained in the inner

bath 80 and the outer bath 81. Those liquid level sensors

20 82a and 82b are wire-connected as signal input devices to

the block controller (BC) 11, and send the detected

positions of the liquid levels to the block controller (BC)

11 as output signals.

[0054]

25 A circulation supply circuit 84 which supplies a

chemical solution in circulation during the etching of

wafers W is connected between the inner bath 80 and the

outer bath 81. One of the circulation supply circuit 84 is connected to the bottom of the outer bath 81, a pump 86, a temperature control unit 88 and a filter 90 are laid out in order in a midway of the circulation supply circuit 84, and the other of the circulation supply circuit 84 is connected to a nozzle in the inner bath 80. Therefore, the chemical solution which has overflowed from the inner bath 80 to the outer bath 81 flows into the circulation supply circuit 84, passes the temperature control unit 88 and the filter 90, in order, for temperature regulation and filtering by the activation of the pump 86, and then is supplied into the inner bath 80 again through the nozzle. The nozzle is laid out under the outer bath 81 and is so constructed as to supply a chemical solution toward the top surface of the wafer W.

[0055]

The temperature control unit 88 has a function of pre-cooling or pre-heating a chemical solution to be supplied into the inner bath 80 from the circulation supply circuit 84 before bathing so that the temperature of the chemical solution in the inner bath 80 does not become lower than or higher than a predetermined process temperature. The supply of a pre-cooled or pre-heated chemical solution into the inner bath 80 this way can keep the temperature of the chemical solution in the inner bath 80. The temperature control unit 88 is wire-connected as a signal output device to the block controller (BC) 11, and receives a control

signal output from the block controller (BC) 11. For
instance, the temperature control unit 88 comprises a heater,
a heat exchanger and coolant supply means, and a valve
disposed in the coolant supply passage for supplying a
5   coolant into the heat exchanger and the heater are connected
to the block controller (BC) 11. A predetermined control
signal is sent to either the heater or the valve via the
block controller (BC) 11 as needed.

[0056]

10   A branch pipe 92 for flow of the chemical solution in
the circulation supply circuit 84 to the outer bath 81 is
connected to a midway of the circulation supply circuit 84,
and the branch pipe 92 is provided with a
concentration/temperature detecting section 95 for detecting
15   the concentration and the temperature of a chemical solution.
The concentration/temperature detecting section 95 is wire-
connected to the block controller (BC) 11 as a signal input
device. The concentration/temperature detecting section 95
is provided with a thermometer 95a which detects the
20   temperature of the chemical solution, and a densitometer 95b
which detects the concentration of the chemical solution,
and they send the detected temperature and concentration as
output signals to the block controller (BC) 11.

[0057]

25   The branch pipe 92 is thinner than the pipe of the
circulation supply circuit 84; for example, the diameter of
the branch pipe 92 is 1/3 of the diameter of the circulation

supply circuit 84. In this case, as generation of turbulence can be prevented, ultrasonic waves to be used in measuring the concentration are not influenced by the eddy flow even when an ultrasonic densitometer is used in the

5   concentration/temperature detecting section 95. The influence of a change in pressure of the chemical solution, caused by driving of the pump 86, on measurement of the concentration is suppressed. Therefore, highly accurate concentration measuring is possible.

10   [0058]

The first chemical bath 61 is provided with a chemical-solution supply circuit 100 for filling the bath with a chemical solution. The chemical-solution supply circuit 100 has a chemical-solution source 101, a pure-water source 102

15   and a mixture supply section 103 which mixes a chemical solution and pure water. The mixture supply section 103 is wire-connected to the block controller (BC) 11 as a signal output device. The chemical-solution supply circuit 100 serves as chemical solution supplementing means, and is

20   controlled in such a way as to supplement the chemical solution from the chemical-solution source 101, the pure-water source 102 when the concentration of the chemical solution in the first chemical bath 61 drops.

[0059]

25   The other end of the chemical-solution supply circuit 100 is connected to the outer bath 81, so that the adjusted chemical solution temporarily flows to the circulation

supply circuit 84, and is supplied to wafers W from below
the inner bath 80 after its temperature is adjusted.

[0060]

As the first and second chemical baths 63 and 65 have
5   structures and functions nearly the same as those of the
first chemical bath 61 and the piping system discussed above,
the descriptions will be omitted. The first to third rinse
baths 62, 64 and 66 basically have similar structures and
functions. That is, they have a rinse bath comprising an
10   inner bath and an outer bath, and a circulation supply
circuit from which pure water is supplied to the rinse bath.

[0061]

As described above, the process apparatus 10 has
various detection means which detect the statuses of the
15   individual components. That is, as mentioned above, the
liquid-process-unit thermometer 59 and the liquid-process-
unit manometer 60 are provided as detection means to detect
the status of the atmosphere in the liquid process unit 38.
The liquid level sensors 82a and 82b, and the thermometer
20   95a and the densitometer 95b of the
concentration/temperature detecting section 95 are provided
as detection means to detect the statuses of the first
chemical bath 61 and the individual sections of its piping
system. Similar liquid level sensors, and the thermometer
25   and the densitometer of the concentration/temperature
detecting section are provided in the second and third
chemical baths 63 and 65 and the piping systems. Further,

the wafer inspecting device 48 is provided at the interface

section 33 as detection means to detect the storage state of

wafers W, and the wafer detection sensor 57 is provided as

detection means to detect the layout state of wafers W.

5   Other various detection means are provided. They perform

predetermined detections as described above, and send the

detected values as output signals to the block controller

(BC) 11 as shown in FIG. 6.

        [0062]

10   The output signals of the wafer inspecting device 48,

the wafer detection sensor 57, the liquid-process-unit

thermometer 59, the liquid-process-unit manometer 60, the

liquid level sensors 82a and 82b, the thermometer 95a and

the densitometer 95b provided in the

15   concentration/temperature detecting section 95, and other

multiple detection means are sent to the block controller

(BC) 11 at predetermined time intervals, are sent to the AGC

17 via the main controller (MC) 12, and are detected as

detection signals representing the statuses of the

20   individual sections of the process apparatus, so that

changes in the statuses of the individual sections of the

process apparatus can be detected. Further, when the

abnormality detecting section 20 of the main controller (MC)

12 detects a detection signal exceeding an allowable value,

25   the alarm generation section 21 generates an alarm to the

operator.

        [0063]

Next, the control operation of the process system will be described.

In the process apparatus 10, a carrier C constituting one lot is placed on the inspection/load/unload stage 45
5 from the load/unload section 31 or the carrier stock section 35 using the carrier conveying device 42, the lid of the carrier C is opened by the lid open/close mechanism 47, further the window 46 is opened, and the quantity and the storage state of wafers W retained in the carrier C are
10 checked by the wafer inspecting device 48. The carrier C whose abnormality has not been detected by the check is given to the attitude conversion mechanism 51a by the arm 49a, and is given to the wafer vertical holding mechanism 51b after its posture is converted by the attitude
15 conversion mechanism 51a. For the other carrier C, the posture conversion of wafers W is carried out by the attitude conversion mechanism 51a and the wafers W are given to the wafer vertical holding mechanism 51b. Accordingly, 50 wafers W are aligned in the wafer vertical holding
20 mechanism 51b.

[0064]

The wafer vertical holding mechanism 51b is slid toward the wafer conveying device 52 and the wafers W are transferred to the chucks 58a to 58c. The wafer conveying
25 device 52 holding the wafers W is moved to the position of the first chemical bath 61 or the first rinse bath 62 of the liquid process unit 38 along the guide rail 53, the wafers W

are transferred to the conveying device 67, and the liquid

process on the wafers W is initiated. The liquid process

the wafers W is carried out in the order of, for example,

soaking into the first chemical bath 61 and rinsing in the

5   first rinse bath 62, basing into the second chemical bath 63

and rinsing in the second rinse bath 64, and soaking into

the third chemical bath 65 and rinsing in the third rinse

bath 66.

[0065]

10   The wafers W whose processing in the liquid process

unit 38 is finished are transferred to the wafer conveying

device 52, and then transferred to the conveying device 55

of the drying unit 39 to undergo the dry process. The

wafers W that has undergone the dry process are transferred

15   to the wafer conveying device 52, and are returned to the

interface section 33 for checking the status of the wafers W

by the wafer detection sensor 57. If an abnormality in the

status of the wafers W is detected, an action, such as

stopping the liquid process apparatus 1 and doing

20   maintenance, is taken. The wafers W which have undergone

the liquid process and are returned to the interface section

33 can be retained in an empty carrier C mounted on the

inspection/load/unload stage 45 in the opposite procedures

to the procedures of carrying unprocessed wafers W from the

25   carrier stock section 35 to the wafer conveying device 52.

The carrier C where the wafers W which have undergone the

liquid process are retained is carried to the carrier

load/unload section 34 to be sent to the next step.

[0066]

The processing operation on wafers W as objects to be

processed is controlled and executed by the corresponding

5   block controller (BC) 11 and main controller (MC) 12 under

the process control of the host computer 15 and the AGC 17.

[0067]

In each main controller (MC) 12, process data acquired

from the process apparatus 10 through the block controller

10   (BC) 11 is written in the memory 18 shown in FIG. 2. The

process data written in the memory 18 is transferred to the

host computer 15 and the AGC 17 through an independent

channel of the data transmission system 14, such as TCP/IP,

by the HCI 13 and the RAP 16 which are logical interface

15   means associated with external transfer of the process data.

[0068]

Here, the HCI 13 extracts only some preset types of

process data from all the process data stored in the memory

18, writes the data in the HCI transmission buffer 19, and

20   sends the contents of the HCI transmission buffer 19 to the

host computer 15 via the data transmission system 14.

Meanwhile, the RAP 16 reads all the process data from the

memory 18 and transfers the data to the AGC 17.

[0069]

25   The AGC server 17a of the AGC 17 receives the process

data transmitted by the RAP 16 of the main controller (MC)

12 of each process apparatus 10, stores the process data in

the database 24, generates a parameter correction value of each process apparatus from the process data and recipe data, and sends the value to the main controller (MC) 12 to perform process control.

5   [0070]

When receiving a process data transfer request from the AGC client 17b, the AGC server 17a reads the corresponding process data from the database 24, and transmits the data to the AGC client 17b via the communication I/F 22. The

10   process data transferred to the AGC client 17b is converted by the data converting section 26 to data of the format that a client user can use and process, and is displayed on the monitor by the data display section 27. Further, the process data transferred to the AGC client 17b is subjected

15   to analysis and statistical processing in the data analysis section 25, and the analysis results, like the process data, are converted by the data converting section 26 to data of the format that a client user can use and process, and are displayed on the monitor. This achieves integrated control

20   of the entire substrate process system on the AGC client 17b.

[0071]

The data analysis section 25 of the AGC client 17b performs abnormality detection and abnormality prediction of the process apparatus from the results of analyzing the

25   process data, and, when detecting or predicting an abnormality, sends an output to that effect to the monitor through the data display section 27 and informs the AGC

server 17a of that effect. According to the notification, the AGC server 17a performs such control as instructing stopping of the main controller (MC) 12 which is controlling the process apparatus 10 whose abnormality is detected or
5   predicted.

[0072]

Further, the recipe correcting section 28 of the AGC client 17b performs an update process to optimize recipes (process conditions) from the results of analysis on the
10   process data including measured data, such as the results of measuring the film thickness on the substrate.

[0073]

Because the amount of process data to be analyzed in the data analysis section 25 is vast and the amount of alarm
15   information from each process apparatus is also vast, actually, it is not easy to determine the status of the process apparatus from analysis information from the data analysis section 25, and it is often difficult to quickly and sufficiently control an abnormality in apparatus and the
20   service life of the apparatus. The use conditions of the apparatus differ from one user to another, so that even if an abnormality in apparatus and the service life of the apparatus are determined equally from the analysis information from the data analysis section 25, there may be
25   a case where an abnormality in apparatus and reaching the service life of the apparatus have not actually occurred yet. According to the embodiment, therefore, as mentioned above,

the AGC client 17b is provided with the FDC function section
29 to provide functions of defining an abnormality on the
user level in addition detection of an abnormality in
apparatus (generation of an apparatus alarm) to detect, in
real time, the abnormality setting arbitrarily made, so that
an abnormality in apparatus and the service life of the
apparatus can be sufficiently and surely detected or
predicted.

[0074]

The output signals of the wafer inspecting device 48,
the wafer detection sensor 57, the liquid-process-unit
thermometer 59, the liquid-process-unit manometer 60, the
liquid level sensors 82a and 82b, the thermometer 95a and
the densitometer 95b provided in the
concentration/temperature detecting section 95, etc. are
sent to the AGC 17 via the block controller (BC) 11 and the
RAP 16 of the main controller (MC) 12 at predetermined time
intervals, and stored in the database 24 of the AGC server
17a, and alarm information, which is generated by the alarm
generation section 21 when the abnormality detecting section
20 detects detection signals exceeding the allowable values
from those detection means, is also sent to the AGC 17, and
those are stored in the database 24 of the AGC server 17a.
For the generation states of those alarms, the FDC function
section 29 allows a predetermined threshold to be set by the
user level, monitors the generation state of a predetermined
alarm, and gives warning when that generation state reaches

the threshold.

[0075]

As a specific example, an automatic monitoring function can be provided so that when an alarm in one detection means is generated, its entry is automatically made to activate the FDC function, so that the FDC function section 29 automatically starts monitoring. In this case, every time an alarm in various detection means is generated, entry of the FDC function is automatically done in order. Instead of such an automatic monitoring function, arbitrary detection means may be set so that when an alarm is generated in the set detection means, the FDC function is activated.

[0076]

There are multiple detection means which generate alarms, in addition to those mentioned above, and in case of automatic monitoring, the upper limit of the number of entries should be set. It is therefore preferable to provide a function of automatically removing an entry considering that there is a low possibility of a problem having occurred in an apparatus when the threshold is not reached for a given time, and to allow a user to set the function on or off and set its time. It is also possible to provide a function of automatically removing an entry when the time from the initiation of monitoring an alarm to giving of warning or the time from giving of one warning to giving of next warning exceeds a predetermined time, and to allow a user to set the function on or off and set its time.

Further, because of multiple types of alarms, it is preferable to classify all the alarms by, for example, the individual components of the process apparatus 10.

[0077]

5   The typical examples of the generation state of an alarm to be grasped are the number of alarms generated within a predetermined time, and the time from one alarm generation to the next alarm generation, and those can be set as detection conditions. That is, in the former case,

10   setting is done in such a way that warning is given when the number of alarms generated within a predetermined time reaches a predetermined number of times. As shown in FIG. 7, for example, warning is given when the number of alarms generated in one hour reaches four. In the latter case,

15   setting is done in such a way that warning is given when the time from generation of an alarm to generation of the next alarm is within a predetermined time. As shown in FIG. 8, for example, warning is given when, after generation of an alarm, a next alarm is generated in one hour. And, a user

20   can set the "predetermined time" and the "number of alarms generated" in the predetermined time in the former case, and a user can set the time from generation of an alarm to the next alarm generation in the latter case.

[0078]

25   Information about the FDC function section 29 is also displayed on the monitor by the data display section 27. That is, designating an ID of the FDC function changes the

display screen to the FDC function screen through which

various settings and status display can be done. for

example, it is possible to display a list of alarms and

individually designate alarms. In this case, it is

5   preferable to display alarms classification by

classification. It is possible to set the FDC function on

or off from the display screen. It is also possible to set

whether the FDC function should be enabled or no for each

process apparatus. Further, it is possible to make the

10   setting of the detection conditions through the display

screen. Furthermore, warning which is given when the

generation of a predetermined alarm reaches the threshold is

displayed on the display screen. It is possible to do

setting on how to report warning in that case. For example,

15   a messenger service report, a mail report, no report, and so

forth can be set. The accumulated number of times warning

is generated can also be displayed.

[0079]

It is possible to display a graph of the circumstances

20   of alarm generation when a detection condition is designated.

FIG. 9 shows a case of displaying a graph of the number of

alarm generations in a predetermined time, with the time

taken on the abscissa axis and the accumulated number taken

on the vertical axis, and white circle points are point

25   where the number exceeds the threshold and warning is given.

FIG. 10 shows a case of displaying a graph of the time from

one alarm generation to the next alarm generation, with the

number of alarm generations taken on the abscissa axis and the accumulated time taken on the vertical axis, and white circle points are point where the time exceeds the threshold and warning is given.

5   [0080]

In addition, when the host computer 15 is downed, spooling process of process data by the AGC 17 is performed in the embodiment. That is, after recovery, the host computer 15 can immediately acquire process data over the down period from the AGC 17. Accordingly, the tracking process of each process apparatus 10 by the host computer 15 can be resumed immediately after recovery.

[0081]

According to the embodiment, as described above, all or nearly all of detailed process data acquired from each process apparatus 10, typified by detection signals from the wafer inspecting device 48, the wafer detection sensor 57, the liquid-process-unit thermometer 59, the liquid-process-unit manometer 60, the liquid level sensors 82a and 82b, the thermometer and the densitometer provided in the concentration/temperature detecting section 95, etc., can be taken into the AGC 17 and intensively monitored, a change in the status of each process apparatus with time can be detected early. This can enhance the maintenance reliability of the process system including multiple process apparatuses 10. According to the embodiment, optimal process conditions can be automatically acquired from

various viewpoints taking into account a change in the

characteristic of each process apparatus 10 with time by

updating individual pieces of data in recipes to more

preferable values from results of analysis and results of

5   statistics done on detailed process data including measured

data, such as the measured result of the film thickness on

the substrate, so that the reliability of the liquid process

of wafers W can be improved.

[0082]

10   By fetching process data acquired from each process

apparatus 10 into the AGC 17 and performing intensive

monitoring this way, the range of information that can be

grasped as the statuses of the individual process

apparatuses is widened so that an abnormality in apparatus,

15   the degradation state, and the service life can be detected

in greater details and earlier as compared with the case

where the AGC 17 is not provided. When all processes are

performed in the data analysis section 25 of the AGC 17 to

grasp the status of the process apparatus as done

20   conventionally, it is actually often difficult to

sufficiently demonstrate the functions of abnormality

detection and abnormality prediction due to a vast amount of

data to be analyzed. According to the embodiment, however,

the AGC client 17b is provided with the FDC function section

25   29 so that the generation state of an alarm can be analyzed,

besides generation of an apparatus alarm, an abnormality in

apparatus can be detected in real time, thus making it

possible to detect or predict an abnormality in process
apparatus and the service life thereof. Specifically, a
user can set a threshold to give warning on the generation
state of an apparatus alarm, such as the number of alarms

5   generated in a predetermined time or the time from one alarm
generation to the next alarm generation, and it is
determined that an abnormality in apparatus has occurred
when the threshold is reached, so that the status of the
process apparatus can be determined surely on the user level

10   and an abnormality in apparatus and the service life of the
apparatus can be detected or predicted earlier and more
reliably.

[0083]

The present invention is not limited to the embodiment,

15   but can be modified in various forms. Although the FDC
function is executed when the first alarm generation is
detected for predetermined detection means, for example, the
FDC function may be executed from the initial state,
regardless of whether or not alarm generation is detected.

20   Although the FDC function section is provided in the AGC, it
may be provided in the controller of the process apparatus.
Further, the present invention should not necessarily be
premised on the AGC, but the FDC function may be used alone.

[0084]

25   Although the foregoing description of the embodiment
has been given of the apparatus which rinses wafers by
performing a liquid process thereon, it is not restrictive

but can be adapted to other process apparatuses. An object
to be processed is not limited to a wafer. It is to be
noted however that in case of an apparatus which performs a
sequence of processes on an object to be processed as done

5   in the process apparatus of the embodiment, the present
invention is particularly effective for there are multiple
types of information to be detected and the types of alarms
are vast accordingly.

      [0085]

10   Further, although the foregoing description of the
embodiment has been given of the process system which has a
plurality of process apparatuses, the number of process
apparatuses can be one.